PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A23G 9/20, 9/02

A1

(11) International Publication Number: **WO 98/09536**

(43) International Publication Date: 12 March 1998 (12.03.98)

(21) International Application Number: PCT/EP97/04574

(22) International Filing Date: 15 August 1997 (15.08.97)

(30) Priority Data:
96306534.7 9 September 1996 (09.09.96) EP

(34) Countries for which the regional or international application was filed: GB et al.

(71) Applicant (for AU BB CA GB GH IE IL KE LC LK LS MG MW NZ SD SG SL SZ TT UG ZW only): UNILEVER PLC [GB/GB]; Unilever House, Blackfriars, London EC4P 4BQ (GB).

(71) Applicant (for all designated States except AU BB CA GB GH IE IL KE LC LK LS MG MW NZ SD SG SL SZ TT UG ZW): UNILEVER N.V. [NL/NL]; Weena 455, NL-3013 AL Rotterdam (NL).

(72) Inventors: BINLEY, Gary, Norman; 15 Raven Drive, Barton Seagrave, Kettering, Northampton NN15 6SD (GB). BURMESTER, Sabina, Silvia, Hanel; 71 Woodlark Road, Cambridge CB3 0HT (GB). CHIARANUSSATI, Nuj; 23/F Tower 2, Clovelly Court, 12 May Road, Hong Kong (CN). WINCH, Paul, Jonathan; 13457 Velp Avenue, Suamico, WI 54173 (US). WIX, Loyd; 93 Hayway, Rushden, Northamptonshire NN10 6AQ (GB).

(74) Agent: KIRSCH, Susan, Edith; Unilever plc, Patent Division, Colworth House, Sharnbrook, Bedford MK44 1LQ (GB).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: FROZEN AERATED ICE CREAM FREE OF EMULSIFIER AND PREPARATION THEREOF

(57) Abstract

A frozen aerated product having no added emulsifier and preferably no added stabiliser and having a fat content of from 1 to 6 % which satisfies the following conditions: (a) % DF greater than or equal to [0.6 * %F]; (b) % ML100 less than or equal to 100 % - [5.35 * %F]; and (c) an air cell size distribution such that the mean air cell size is less than 40 μM with a standard deviation of less than 20 μM; wherein DF = destabilised fat, F = fat, ML100 = mass loss after 100 minutes.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

FROZEN AERATED ICE CREAM FREE OF EMULSIFIER AND PREPARATION THEREOF

Technical Field of the Invention

The invention relates to a high quality frozen aerated product, particularly an ice cream product and the manufacture thereof, wherein the frozen aerated product has a low fat content and requires no addition of emulsifiers.

Background to the Invention

Traditionally frozen aerated products such as ice cream products contain approximately 8-12% fat in addition to stabilisers and emulsifiers in order to provide the desired quality product. However, it is now preferred to provide such products which are low fat and without additives. To date products provided which are low fat and without added stabilisers and emulsifiers have been inferior in quality in that they are fast melting, have a low percentage of destabilised fat, and are unstable to heat shock and hence quickly become very icy. Furthermore, such products have a reduced creaminess perception.

Clearly it would be advantageous to be able to provide a low fat product having no added emulsifiers, and preferably no added stabilisers or emulsifiers which nevertheless retains its high quality.

Frozen aerated products such as ice cream are usually produced by a continuous process comprising the following steps:

a) homogenising of ingredients
b) pasteurisation
c) cooling
d) freezing and aeration
e) extrusion
f) (optional) deep freezing

Normally the homogenisation step takes place in a first vessel, followed by continuous pasteurisation followed by cooling. The mixture is then transferred to a freezer, for example a scraped surface heat exchanger where the product is frozen to a temperature of approximately -6°C followed by quiescent cooling in a hardening tunnel.

The applicants have surprisingly found that if the product is subjected to cooling and shearing in a screw extruder prior to extrusion and any optional deep freezing, a high quality low fat product may be prepared even in the absence of emulsifiers and preferably also in the absence of stabilisers.

Screw extruders such as single screw and twin screw extruders are widely used in the chemical industry for example in the production of plastics. It has also been proposed to use single screw or twin screw extruders in the freezing of ice-cream, see for example EP 561 118 and EP 401 512.

EP 713 650 discloses a method for manufacturing frozen aerated products in which the composition to be frozen is mixed, aerated and cooled to a temperature equal or less than -8°C prior to extrusion in a single twin screw device.

However, to date it has not been recognised that such screw extruders can advantageously be used to prepare a high quality frozen aerated product having a low fat content and no added emulsifiers or stabilisers.

Disclosure of the Invention

Accordingly the invention provides a frozen aerated product comprising;

(i) 1 to 6% fat
(ii) 0% emulsifier
(iii) 0 to 1.0% stabiliser

which satisfies the following conditions:

(a) % DF greater than or equal to [0.6 * %F];
(b) % ML100 less than or equal to 100% - [5.35 * %F]; and
(c) An air cell size distribution such that the mean air cell size is less than 40 μM with a standard deviation of less than 20 μM;

wherein DF = destabilised fat
F = fat
ML100 = mass loss after 100 minutes

Preferably the product has from 0 to 0.5% stabiliser, more preferably from 0 to 0.25 % stabiliser, even more preferred from 0 to 0.15% stabiliser, most preferred 0% stabiliser.

Preferably the product has 2% fat, most preferably 3% fat. By fat is meant triglycerides and not mono- or di-glycerides.

Preferably the product has an air cell size distribution such that the mean air cell size is less than 25μM, more preferably less than 20μM.

A convenient process for the preparation of the frozen aerated product according to the invention comprises subjecting the product to be frozen to shear forces and cooling in a screw extruder prior to extrusion and optional

deep freezing.

The screw extruder can be either a single or multiple screw extruder, preferably however a single or twin screw extruder is used.

Preferably the product is extruded at a temperature of from -10°C to -30°C, more preferably from -10°C to -25°C, most preferably -10°C to -15°C.

The screw extruder may be employed after the conventional freezing and aeration step within for example a scraped surface heat exchanger. Alternatively all steps prior to extrusion, including if desirable homogenisation and pasteurisation, may be conducted within the screw extruder as described in either EP 713 650 or our copending European patent application EPA 96302718.0

Frozen aerated products according to the invention have been shown to have an increased perception of fat, characterised by increases in creamy texture, thickness, smoothness, initial smoothness and reduction of ice crystal quantity in mouth and ice crystal size in mouth.

The percentage destabilised fat was measured using a solvent extraction technique. 10g of ice cream was melted for 4 hours at ambient temperature before extraction with petroleum solvent. The solvent was evaporated and the extracted destabilised fat was weighed, this was expressed as a percent of the weight of the total fat in the ice cream.

The percentage mass loss after 100 minutes was determined by measuring the weight of melted ice cream every minute over the required time period.

The air cell distribution was determined using low

temperature scanning electron microscopy (SEM).

The mean air cell size measured for the products of the invention is thought to be important for providing products having a creamy texture. Conventionally prepared ice cream, which is stabilised and emulsified will have a mean air cell size of from 60 to 100μM.

Preferably the frozen aerated product of the invention is a milk or fruit based frozen aerated confection such as ice cream, frozen yoghurt, sherbet, sorbet, and frozen custard.

Suitable ingredients and their preferred levels for such a frozen aerated confection are for example: Ice cream/custard: milk fat 1-6 wt%, milk solids non fat 2 to 15 wt%, sugar or other sweeteners 0.01 to 35 wt%, flavours 0-5 wt%, water 30 to 85 %wt.

Any stabiliser used in ice cream is suitable, for example Locust Bean Gum (LBG), Carrageenan, Guar gum, gelatin, CMC (Carboxy methyl cellulose) gum, pectin, algin products, and mixtures thereof.

Examples

Example 1

An ice cream mixture having the following formulation:

4.5% Fat
13.91% Skimmed Milk Powder
16.76% sucrose
0.4% flavour
Water to 100%

was prepared in the conventional way and initially frozen in a standard ice cream freezer (scraped surface heat exchanger, SSHE) to a temperature of -7.6°C. Air was added to the mix in a ratio of 1:1.

The outlet of the SSHE was connected by pipework to a single screw extruder with a refrigerated jacket which continued to freeze the ice cream to a temperature of < -10°C. The single screw extruder had the following geometry:

Barrel length	0.75m
Barrel diameter	0.2m
Screw pitch	0.135m (2 start)
Screw Channel depth	15 mm

The single screw extruder was controlled to maintain a constant inlet pressure of 7 barg and a torque on the screw of 1500 Nm. The outlet pressure was 8 barg. The flow rate was 250 L/hr. During production the torque level was increased and when the torque reached 1500Nm the extruded ice cream changed colour becoming whiter.

An ice cream product was obtained which was emulsifier and stabiliser free having 10.3% destabilised fat, 72% mass loss after 100 minutes, and the mean air cell size was 20μM.

Furthermore, the ice-cream was of high quality having an excellent creamy texture and smoothness. A trained sensory panel perceived this low fat formulation to be as creamy as a commercial sample prepared in the same way having an identical formulation except that the fat content was 12%.

Example 2

An ice cream mixture having the following formulation:

1.0% Fat
14.76% Skimmed Milk Powder
17.37% sugars
0.22% stabiliser
0.4% flavour
Water to 100%

was prepared in the conventional way and initially frozen in a standard ice cream freezer (scraped surface heat exchanger, SSHE) to a temperature of -6.2°C. Air was added to the mix in a ratio of 1:1.

The outlet of the SSHE was connected by pipework to a single screw extruder with a refrigerated jacket which continued to freeze the ice cream to a temperature of < -10°C. The single screw extruder had the following geometry:

Barrel length	0.75m
Barrel diameter	0.2m
Screw pitch	0.135m (2 start)
Screw Channel depth	15 mm

The single screw extruder was controlled to maintain a constant inlet pressure of 7 barg and a torque on the screw of 1800 Nm. The outlet pressure was 8 barg. The flow rate was 250 L/hr.

An ice cream product was obtained which was emulsifier free

having 0.91% destabilised fat, 91.8% mass loss after 100 minutes, and the mean air cell size was 17.6μM, with a standard deviation of 9.9μM.

Example 3

An ice cream mixture having the following formulation:

4.5% Fat
13.91% Skimmed Milk Powder
16.76% sucrose
0.22% stabiliser
0.4% flavour
Water to 100%

was prepared in the conventional way and initially frozen in a standard ice cream freezer (scraped surface heat exchanger, SSHE) to a temperature of -6.2°C. Air was added to the mix in a ratio of 1:1.

The outlet of the SSHE was connected by pipework to a single screw extruder with a refrigerated jacket which continued to freeze the ice cream to a temperature of < -10°C. The single screw extruder had the following geometry:

Barrel length	0.75m
Barrel diameter	0.2m
Screw pitch	0.135m (2 start)
Screw Channel depth	15 mm

The single screw extruder was controlled to maintain a constant inlet pressure of 7 barg and a torque on the screw of 1800 Nm. The outlet pressure was 8 barg. The flow rate was 250 L/hr.

An ice cream product was obtained which was emulsifier free having 4.86% destabilised fat, 35% mass loss after 100 minutes, and the mean air cell size was 18.9μM, with a

standard deviation of 12.8μM.

Example 4

An ice cream mixture having the following formulation:

2.0% Fat
14.52% Skimmed Milk Powder
17.19% sugars
0.22% stabiliser
0.4% flavour
Water to 100%

was prepared in the conventional way and initially frozen in a standard ice cream freezer (scraped surface heat exchanger, SSHE) to a temperature of -6.2°C. Air was added to the mix in a ratio of 1:1.

The outlet of the SSHE was connected by pipework to a single screw extruder with a refrigerated jacket which continued to freeze the ice cream to a temperature of < -10°C. The single screw extruder had the following geometry:

Barrel length	0.75m
Barrel diameter	0.2m
Screw pitch	0.135m (2 start)
Screw Channel depth	15 mm

The single screw extruder was controlled to maintain a constant inlet pressure of 7 barg and a torque on the screw of 1800 Nm. The outlet pressure was 8 barg. The flow rate was 250 L/hr.

An ice cream product was obtained which was emulsifier free having 1.23% destabilised fat, 89.3% mass loss after 100 minutes, and the mean air cell size was 18.4μM, with a standard deviation of 12.3μM.

CLAIMS

1. A frozen aerated product comprising:

(i) 1 to 6% fat
(ii) 0% emulsifier
(iii) 0 to 1.0% stabiliser
which satisfies the following conditions:

(a) % DF greater than or equal to [0.6 * %F];
(b) % ML100 less than or equal to 100% - [5.35 * %F]; and
(c) An air cell size distribution such that the mean air cell size is less than 40 μM with a standard deviation of less than 20 μM;

wherein DF = destabilised fat
F = fat
ML100 = mass loss after 100 minutes

2. A frozen aerated product according to claim 1 wherein the product comprises from 0 to 0.5%, preferably 0 to 0.25% most preferably form 0 to 0.15% stabiliser.

3. A frozen aerated product according to claim 1 or 2 wherein the product comprises 0% stabiliser.

4. A process for the preparation of a frozen aerated product according to any preceding claim wherein the product to be frozen is subjected to shear forces and cooling in a screw extruder prior to extrusion and optional deep freezing.

5. A process according to claim 4 wherein the product to be frozen is initially cooled to approximately -6°C in a freezer before transferring into the screw extruder.

6. A process according to claim 5 wherein the freezer is a scraped surface heat exchanger.

7. A process for the preparation of a frozen aerated product according to any one of claims 1 to 3 comprising the steps of

(a) homogenising of ingredients;
(b) pasteurisation;
(c) cooling;
(d) freezing and aeration;
(e) extrusion; and
(f) (optional) deep freezing;

wherein steps (a) to (d) are conducted in a screw extruder.

8. A process according to any one of claims 4 to 7 wherein the screw extruder is a single screw extruder.

9. A process according to any one of claims 4 to 7 wherein the screw extruder is a twin screw extruder.

10. A process according to any one of Claims 4 to 7 wherein the product is extruded at a temperature of from -10°C to -30°C, preferably -10°C to -25°C, most preferably -10°C to -15°C.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 97/04574

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A23G9/20 A23G9/02

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A23G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 351 476 A (GOAVEC) 24 January 1990 see column 2, line 34-36; claims; examples 1-6	1-6,8
Y	see column 5, line 44 - column 6, line 7 see column 1, line 1 - line 52	7,10
Y	DE 25 38 858 A (POVIGNA TARCISIO) 10 March 1977 see the whole document	7,10
X	EP 0 559 316 A (MORINAGA MILK INDUS.) 8 September 1993 see page 10, line 21 - line 35; tables 1,2,4 see page 5, line 7 - line 10 see page 2, line 30-31; claims; examples 3,7,9	1-3

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 November 1997	28/11/1997

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax. (+31-70) 340-3016	Guyon, R

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/EP 97/04574

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 97 39637 A (UNILEVER) 30 October 1997 see the whole document	1-10
A	WO 92 11769 A (THE PILLSBURY CORP.) 23 July 1992 see claims; examples 1,2,6	1-5,10
Y	EP 0 713 650 A (NESTLE) 29 May 1996 cited in the application see the whole document	1,4-6, 8-10
Y	EP 0 401 512 A (F. ROGGE ET AL.) 12 December 1990 see column 3, line 53 - column 4, line 17 see column 7, line 30-42 see page 4, column 49-54 see column 5, line 48 - column 6, line 33	1,4-6, 8-10
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 423 (C-638), 20 September 1989 & JP 01 160458 A (NAKAMURA TAMOTSU), 23 June 1989, see abstract	1
A	WO 93 21777 A (UNILEVER) 11 November 1993 see page 111, line 10-16; examples	1-3
A	EP 0 438 201 A (CAMPINA MELKUNIE) 24 July 1991 see the whole document	1-3
A	EP 0 561 118 A (E. WINDHAB ET AL.) 22 September 1993 see the whole document	1,4-6, 8-10

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int tional Application No
PCT/EP 97/04574

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 351476 A	24-01-90	AU 603693 B	22-11-90
		AU 2100088 A	22-02-90
		US 5024066 A	18-06-91
DE 2538858 A	10-03-77	NONE	
EP 559316 A	08-09-93	JP 5328905 A	14-12-93
		CA 2087648 A	23-07-93
		DE 559316 T	24-02-94
		US 5403611 A	04-04-95
WO 9739637 A	30-10-97	NONE	
WO 9211769 A	23-07-92	US 5112626 A	12-05-92
		US 5175013 A	29-12-92
		AU 653770 B	13-10-94
		AU 9148791 A	17-08-92
		CA 2099243 A,C	01-07-92
		DE 69108569 D	04-05-95
		DE 69108569 T	03-08-95
		EP 0565596 A	20-10-93
		JP 6506825 T	04-08-94
EP 713650 A	29-05-96	AU 3770095 A	30-05-96
		CA 2163284 A	24-05-96
		CN 1132595 A	09-10-96
		CZ 9503076 A	17-07-96
		FI 955594 A	24-05-96
		HU 74491 A	28-01-97
		JP 8205783 A	13-08-96
		NO 954687 A	24-05-96
		PL 311434 A	27-05-96
		SG 35034 A	01-02-97
		SK 144495 A	05-06-96
EP 401512 A	12-12-90	DE 3918268 C	26-07-90
		AT 116528 T	15-01-95
		AU 5670190 A	07-01-91
		WO 9014775 A	13-12-90
		ES 2066900 T	16-03-95

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ional Application No
PCT/EP 97/04574

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9321777 A	11-11-93	AT 155650 T	15-08-97
		AU 667111 B	07-03-96
		AU 4265793 A	29-11-93
		CA 2134125 A	11-11-93
		CN 1079110 A	08-12-93
		DE 69312482 D	04-09-97
		EP 0637207 A	08-02-95
		FI 944988 A	24-10-94
		NO 944022 A	24-10-94
		US 5486373 A	23-01-96
		ZA 9302842 A	24-10-94
EP 438201 A	24-07-91	NL 9000101 A	16-08-91
		DE 69101561 D	11-05-94
		DE 69101561 T	28-07-94
		JP 4218340 A	07-08-92
		US 5308628 A	03-05-94
EP 561118 A	22-09-93	DE 4202231 C	09-06-93
		US 5345781 A	13-09-94
		AT 158151 T	15-10-97